CIM CONTROL DESIGN USING GRAFCET

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For you, my mom and dad

For your truly support and undivided love

For making me the person

Who I am today.....

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ABSTRACT

This project is concerned with learning and exploring industrial automation technologies, such as control systems, Computer Integrated Manufacturing system and the relationship between these major components. The CIM70A System will be used in this project and located at Automation Lab, Kuithho. The project is divided into two major parts. In the first part, the author familiarized herself with the operation and all the functions of the related industrial components of the CIM70A System, such as the sensors, actuators, and the valves. In the second part, the author aimed to study GRAFCET and attempts to relate between the graphical representation and mathematical model using PLC programs. With this formal approach, the programming will be written more neatly, well arranged and standardized. This project successfully explores the possibility of designing the control program using GRAFCET.

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CHAPTER I

INTRODUCTION

1.1 Background

In early 1970's, the programmable logic controller (PLC) were becoming more powerful and more extensively used, the need to describe increasingly logic controller becoming evident. Thus, an efficient approach which can represent the control process by using the graphical representation perhaps a good solution to helps the designer in order to programming the PLCs. There has been a growing interest in programming languages for PLCs. In particular, the sequential function chart (SFC), an international standard based on the GRAFCET language was introduced in France in 1977.

The GRAFCET language has been used as one of the most important means for designing, programming and describing logic sequential control systems. This powerful graphical language dedicated to the specification of the behavior of sequential logical systems. It is standardized by CEI and its semantic is defined for this type of applications. The [1] and [2], concluded that the GRAFCET is a very good tool for logic controller specification, and the graphical nature of the language makes GRAFCET easy to learn and use.

With a tremendous number of inputs and outputs, the model of the control system or application has typically over fifty steps and transitions and therefore, it is difficult for a human operator to understand it; the GRAFCET formalism loses one of its major qualities namely to provide a graphical representation model of the sequential model [3].

GRAFCET also has contributions in design recovery for relay ladder logic. The objective in design recovery is to analyze existing source code and construct from it a structured representation of the program logic. In [4], it has been proved that an existing RLL programs can be translate into GRAFCET that clearly represents the sequential control logic relative to the specified process control application.

For better understanding, a definition and theory of the GRAFCET, PLC, and CIM system is presented. Methods for using GRAFCET as a design tool are shown through the use of examples.

1.2 Problem Statement

Dealing with the computer integrated manufacturing system, we will involve with a great number of programmable logic controller as its workhorse. Many existing programs for the PLCs are written in relay ladder logic (RLL), which in its most primitive form is a graphical representation of Boolean switching functions based on an analogy to physical relay systems. Although RLL is widely used and understood by industry technical person, the RLL is often difficult to debug and modify because its graphical representation of switching logic makes ordinary person difficult to understand the sequential in the program design.

Furthermore, there is no formality in order to design the control system. There is one approach that commonly used in order to develop the control program using PLC. Namely, try and error approach or heuristics approach, which will be differed from one designer to other. Besides, this unstructured approach will not guarantee the safety, the working, the readability and understanding of the operation of the system.

How to represent the logic controller systems in a formal way?

In order to solve the stated problem, this project proposed a formal approach namely GRAFCET as a design tool in order to build up more structured control program.

1.3 Objectives of Project

This project is consisted of two parts. In the Part I, the objectives of this work is to familiarize with the system itself, the function and the controlling elements. Since the PLC as the controller, the CX Programmer as the programming tool will also be learned in this part.

For Part II, the objective is to write the programming using the GRAFCET as a graphical tool in order to develop the working control program that in lined with the existing system. In further, the objective is to provide a set of laboratory manual how to start and use GRACET as a design tool as a references materials for the students or lecturers for future work. As mentioned above, the main objective of this paper is, to design the CIM70A system control program using the GRAFCET that clearly represents the sequential control logic relative to the specified process control application. Also to show that GRAFCET can be used as a design tool that can helps the designers to come out with the structured, safety, working and readability control program.

In this project, we mainly concentrate on the modular of Pick and Place station of CIM70A system as the test bed. We tried to design and develop the control program of this modular and intent to build the communication path between the Master of the PLC (which controlling the conveyor line) and the Slave PLC that controlling the Pick and Place station as the final target.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The cost of developing software for the logic controller in the manufacturing world become increasing by a day. Furthermore, in designing the representation of the logic controller such as PLC, many companies using a different languages. In the desire to improve the capabilities of this logic controller, these languages become more complex. This is in contradiction with the main goals of the PLCs, which is that the PLC is a very simple system because it is very important that PLC must be reliable. There obviously needs to be a consistent philosophy for developing reusable code for manufacturing controllers systems.

In today's economic context, the design of these control applications is of a great impact in terms of productivity and production costs. Because of these costs, of the complexity of the control systems and the multiple hardware/software combinations, the designer has to take the safety of these systems into account. In this context, it is necessary to provide the designer with verification methods that ensure the safety and liveness of the control system. In deep, the verification methods will help the designer to troubleshoot the programs while the error occurs in the production.

One way is to ensure the safety of the PLC programs is by using "framework" or standard while programming process began.

As concluded in [1], the usage of Grafcet as a very good tool for logic controller specification has been approved. It allows modeling of concurrency and synchronization. Above all, the input-output behavior is specified without doubt. When some parts of the logic controller can be described separately, one can use macrosteps to simplify the model. Also, the comparison was made between State Table, Petri Net, RLL and Grafcet, and it make an evident that the Grafcet applications was the easiest among all.

The strength of the Grafcet also had shown in [2]. The graphical nature of the language makes Grafcet easy to learn and use. The ability to test different ideas quickly has been very useful in determining the final design. The Grafcet helps the designer determine: modularization of the code, functions that can be performed in parallel, communication between parallel processes, and problems in control flow. The further extension of the Grafcet usage has been proved in [3], which touched on how this tool can be applied to the reduction of a model in a specific context such as for the model that has typically over fifty steps and transitions. The Grafcet also has been successful in [4] in order to converting existing RLL programs into the form that considerably easier to understand and it also helps to modify the programs. Some of Grafcet contributions were touched in [5, 6, 7]. Furthermore, the Grafcet can be implemented to avoid the damages or system failures during the plant operation, due to interactions between human operators and plant. This statement was fully supported in [8, 9], that also shown that the Grafcet language has a particular characteristics that support supervision of external actions over a process. The results demonstrated in [8, 9] also shown that Grafctet implementation over a

PLC can avoid human errors and can indicate on a set of outputs, the parts and variables of the plant that do not satisfy the interaction demand conditions. In order to make the Grafcet success, [10] introduced two different techniques to make proofs on the properties of this language.

2.2 Historical Development

In 1975, the working group called "Logical Systems" from AFCET (Association Française de Cybernétique Economique et Technique) create the standardisation of a requirement representation for a logical automated system. This group trying to define a simple formalism, accepted by everyone and well-adapted for the representation of the sequential evolutions of a system understandable by designers as well as by users and providing potentially easiness for the implementation with hardware and/or software solutions. In December 1977, the Grafcet which means Functional Graph of a Step-Transition Command was derived as a tool of state graphs. After Grafcet had been introduced in higher and technical education, it was supported by the arrival of the first programming languages allowing implementation of Grafcet specification models on industrial logic controllers; it became an AFNOR standard in 1982 known under the reference NF C03190.

Aware of the necessity to precise how to implement a Grafcet specification with hardware and/or software, a synthesis document on recommended interpretations for the transformation from the Grafcet specification model to a specific realization. This thought led the group to propose in 1987 in an AFCET synthesis document, a certain number of Grafcet extensions to meet users' expectations. So as to strengthen the diffusion of Grafcet, and thanks to the efficient